Measurement of Neutron-Production Double-Differential Cross Sections for Continuous-Energy-Neutron-Incidence on Fe and Pb by Liquid Organic Scintillator

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Nuclear data in the intermediate energy region are required for programs of accelerator driven transmutation system, radiotherapy, and space development. Neutron production cross section measurements for proton incidence have been studied in wide energy range to get reliabilities of model calculations, or to improve nuclear reaction models. However, it has been difficult to get their reliabilities for neutron-incident data. Neutron-incidence cross section data are very scarce in the intermediate energy region. The purpose of this study is to measure neutron-production double-differential cross sections for neutron-incidence in the wide intermediate energy range.

The experiment was performed at WNR facility in Los Alamos Neutron Science Center (LANSCE). Incident neutrons were generated from the spallation-neutron-source that allowed inclusive neutron-incidence measurement. The flight path from the spallation target to the sample was about 90 m. Fe and Pb were selected as samples. The fission chamber was set in front of the sample to obtain the number of incident neutrons. To detect emitted neutrons NE213 liquid organic scintillators (127 mm thick and 127 mm in diameter) were arranged at 15°, 30°, 60°, 90°, 120°, and 150°. NE102A plastic scintillators of 10 mm thick were also set in front of NE213 detectors to eliminate charged-particle events. Along with those experiments, spallation neutrons were directly induced into the NE213, and response functions were also measured for all NE213s used in this study.

To determine incident neutron energy, time-of-flight technique was used on the assumptions that the total time-of-flight was exhausted only by incident-neutron. To discriminate neutron and gamma-ray events, the two-gates charge integration method was adopted. Emitted neutron spectra were determined by unfolding charge-integration spectra with response functions of the neutron detector. Because neutron detectors were not large enough to differentiate neutron energy above about 120 MeV in respect to charge-integration, data analysis was performed up to around this energy. Results were compared with calculations by the GNASH code.

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